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AN EVALUATION OF A TEST METHOD TO DETERMINE THE EASE OF IGNITABILITY OF PRIMARY DECK COVERINGS

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16. Abstract

This project provides information on the fire safety of materials used as primary deck coverings for ships. The ease of ignitability for selected materials was determined using the fire test method outlined in the International Maritime Organization document FP 31/WP.4, Annex 3. All the primary deck coverings that were investigated were found to be "not readily ignitable" in terms of the pass/fail criteria specified in the test method. In addition, a selection of other materials were examined using this test method. Most of these materials, including balsa wood, plexiglass and foamed sheets of polystyrene, passed the test.

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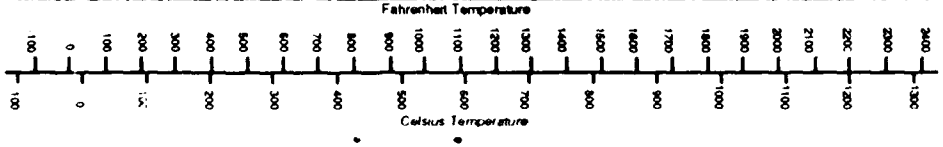
Conversions to Metric Measures

When you know (symbol)	Multiply by	To find (symbol)
Length		
inches (in)	2.540	centimeters (cm)
feet (ft)	30.48	centimeters (cm)
feet (ft)	0.3048	meters (m)
Area		
square inches (in^2)	6.452	square centimeters (cm^2)
square feet (ft^2)	929.0	square centimeters (cm^2)
square feet (ft^2)	0.09290	square meters (m^2)
Volume		
fluid ounces, US (fl oz)	29.57	milliliters (ml); cubic centimeters (cm^3)
gallons, US liquid (gal)	3.785	liters (l)
cubic feet (ft^3)	0.02832	cubic meters (m^3)
cubic yards (yd^3)	0.7646	cubic meters (m^3)
Mass (weight)		
ounces, avoirdupois (oz)	28.35	grams (g)
pounds (lb)	0.4536	kilograms (kg)
Density		
pounds per cubic inch (lb/in^3)	27.68	grams per cubic centimeter (g/cm^3)
pounds per cubic foot (lb/ft^3)	16.02	kilograms per cubic meter (kg/m^3)
Pressure		
pounds per square inch (psi)	6895	pascals (Pa); newtons per square meter (N/m^2)
pounds per square inch (psi)	0.0703	kilograms per square centimeter (kg/cm^2)
pounds per square inch (psi)	51.71	millimeters of mercury (mm Hg) at 0°C
pounds per square inch (psi)	0.06895	bars (10^5 N/m^2)
inches of water (in H_2O) at 60°F	1.867	millimeters of mercury (mm Hg) at 0°C
inches of water (in H_2O) at 60°F	248.9	pascals (Pa)
inches of water (in H_2O) at 60°F	0.00248	bars (10^5 N/m^2)
inches of mercury (in Hg) at 32°F	3386	pascals (Pa)
inches of mercury (in Hg) at 32°F	0.03386	bars (10^5 N/m^2)
Energy		
British thermal units (Btu)	1055	joules (J); newton-meter (Nm)
British thermal units (Btu)	0.2520	kilocalories (kcal)
Thermal Conductance		
Btu / hr - ft^2 - °F	0.0001356	calories / sec - cm^2 - °C
Btu / hr - ft^2 - °F	0.4882	calories / hr - cm^2 - °C
Btu / hr - ft^2 - °F	0.0005678	watts / cm^2 - °C
Heat Flow		
Btu / hr - ft^2	0.00007535	calories / sec - cm^2
Btu / hr - ft^2	0.2712	calories / hr -cm^2
Btu / hr - ft^2	0.0003154	watts / cm^2

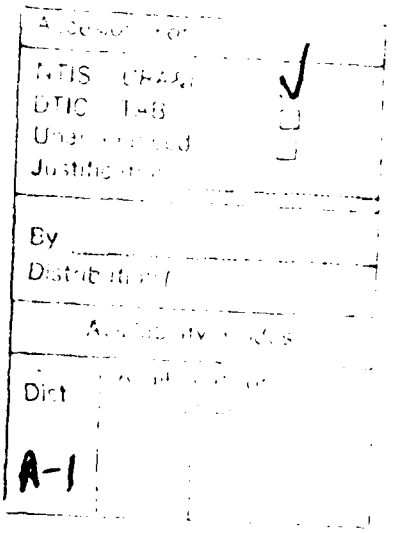


Conversions from Metric Measures

When you know (symbol)	Multiply by	To find (symbol)
Length		
millimeters (mm)	0.03937	inches (in)
centimeters (cm)	0.3937	inches (in)
meters (m)	39.37	inches (in)
Meters (m)	3.281	feet (ft)
Area		
square centimeters (cm^2)	0.1550	square inches (in^2)
square centimeters (cm^2)	0.001076	square feet (ft^2)
square meters (m^2)	1550	square inches (in^2)
square meters (m^2)	10.76	square feet (ft^2)
square meters (m^2)	1.196	square yards (yd^2)
Volume		
milliliters (ml)	0.03381	fluid ounces, US (fl oz)
liters (l)	0.2642	gallons, US liquid (gal)
liters (l)	0.03531	cubic feet (ft^3)
cubic centimeters (cm^3)	0.06102	cubic inches (in^3)
cubic meters (m^3)	35.31	cubic feet (ft^3)
cubic meters (m^3)	1.308	cubic yards (yd^3)
Mass (weight)		
grams (g)	0.03527	ounces, avoirdupois (oz)
grams (g)	0.002205	pounds (lb)
kilograms (kg)	2.205	pounds (lb)
Density		
grams per cubic centimeter (g/cm^3)	0.03613	pounds per cubic inch (lb/in^3)
kilograms per cubic meter (kg/m^3)	0.06243	pounds per cubic foot (lb/ft^3)
Pressure		
pascals (Pa); newtons per sq. meter (N/m^2)	0.000145	pounds per square inch (psi)
bars (10^5 N/m^2)	14.50	pounds per square inch (psi)
kilograms per square centimeter (kg/cm^2)	14.22	pounds per square inch (psi)
millimeters of mercury (mm Hg) at 0°C	0.01934	pounds per square inch (psi)
millimeters of mercury (mm Hg) at 0°C	0.5357	inches of water (in H_2O) at 60°F
bars (10^5 N/m^2)	401.8	inches of water (in H_2O) at 60°F
pascals (Pa)	0.00402	inches of water (in H_2O) at 60°F
pascals (Pa)	0.000295	inches of mercury (in Hg) at 32°F
bars (10^5 N/m^2)	29.53	inches of mercury (in Hg) at 32°F
Energy		
kilojoules	0.9478	British thermal units (Btu)
kilocalories	3.968	British thermal units (Btu)
Thermal Conductance		
calories / sec - cm^2 - °C	7373	Btu / hr - ft^2 - °F
watts / cm^2 - °C	1761	Btu / hr - ft^2 - °F
Heat Flow		
calories / sec - cm^2	13270	Btu / hr - ft^2

FORWARD

This report outlines the results of a project designed to evaluate the ease of ignitability of primary deck coverings. Mr. Klaus Wahle was program manager for this project. Mses. Denise Baird and Nancy Hahn conducted the tests. Mr. Dewey Gillard supervised the operation of the MF&SRD Avery Point Laboratory.



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1.0 BACKGROUND

The International Maritime Organization is considering the modification of regulations which restrict the use of "readily ignitable" primary deck coverings on ships. Paragraph 8 of Regulation 34, and, Paragraph 3 of Regulation 49 of Chapter II-2 of the "INTERNATIONAL CONVENTION FOR THE SAFETY OF LIFE AT SEA" require that primary deck coverings, if applied within accommodation and service and control stations, be of an approved material which will not readily ignite. Approval is based on a test procedure prescribed in IMO Assembly Resolution A214(VII) of the International Maritime Organization Fire Test Procedures. It has been proposed to replace this test with that prescribed in FP 31/WP.4, Annex 3 (See Appendix A). The replacement test is based on a fire test method used for United Kingdom registered ships. This project was developed to evaluate this test method.

2.0 EXPERIMENTAL

2.1 LABORATORY PROCEDURES

For the primary deck coverings, the test procedure specified in FP 31/WP.4, Annex 3, was used to determine the ease of ignitability. A copy of this test procedure is provided in Appendix A for reference. Briefly, the method uses a 150 mm x 150 mm (6 in. x 6 in.) test specimen mounted on a 3 mm (1/8 in.) steel plate. A 32 mm (1.23 in.) natural gas flame is directed onto the inverted test sample from below for a period of one minute. The material passes the test (i.e., is not readily ignitable) provided flaming, if any, ceases within 20 seconds after the removal of the burner.

In addition to the primary deck coverings, other materials were also evaluated in order to obtain information about the ease of ignitabilty, as defined by this test, for a wide range of materials. Two thin film wallcoverings with known ASTM E-84 Flame Spread (FS) values were tested. Thirteen other materials were selected and evaluated. A list of the materials which were tested is provided in Appendix B for reference. For screening tests using other materials, the same test protocol was followed, with the exception that only one test sample was used for each material.

Natural gas supplied by the LINDE Division, Union Carbide, was used. Specifications for the range of composition and the energy content of this fuel are listed in Table 1. All tests were conducted in a fume hood that was free from drafts. Before testing, all materials were conditioned for a period of 24 hours at a temperature of 23 $\pm$ 3°C, and a relative humidity of 50 $\pm$ 5%. The test specimens were taken from a conditioning chamber immediately prior to testing.

TABLE 1
PROPERTIES OF NATURAL GAS

Hydrocarbon Content	Volume percent
Methane	83 - 99
Ethane	1 - 13
Propane	0.1 - 3
Butane	0.2 - 1
Energy Content	**BTU/cubic foot***
Total Calorific Value	1016
Net Calorific Value	915

* The calorific value is for dry gas at 60°F and 30 inches of mercury. The calorific values listed are certified values for the gas cylinder that was used for these tests.

2.2 PRIMARY DECK COVERINGS

The primary deck coverings that were evaluated were separated into two classifications: inorganic cements and organic deck tiles and planking. Inorganic cements included formulations based on magnesium oxychloride (magnesite) and portland cements. Two high density magnesites were evaluated: a fiber-reinforced magnesite (Duracrete), and a latex-based terrazzo (Dex-O-Tex P-61). Two lightweight cements were evaluated: a foamed, closed-cell magnesite (Duraspray), and a mixture of vermiculite and portland cement (Fendolite MII). Organic-based decking systems included: asphalt and vinyl chloride tiles, and an asphalt-impregnated fiberboard boat planking. The primary deck covering materials were mounted on 3 mm (1/8 in.) steel plate using application techniques recommended by the manufacturer.

Test results are summarized in Table 2. Tests were made on two locations, center and edge, on three sample plates for each material evaluated. Seven materials were investigated. All of the materials that were evaluated passed the test. Therefore, in accordance with the pass/fail criteria, they were "deemed to be not readily ignitable." Only minor damage was observed for primary deck coverings formulated using inorganic cements. For deck tiles, especially the polyvinyl chloride tile, the material tended to delaminate from the steel plate in the region of flame impingment. Separations up to 18 mm (3/4 in.) were observed due to the delamination.

TABLE 2
PASS/FAIL RESPONSE OF PRIMARY DECKING MATERIALS TO THE IMO FIRE TEST (FP 31/WP.4, Annex 3)

Decking Type	Description (thickness)	Response (pass/fail)
A. INORGANIC CEMENTS		
Duracrete(M52)*	A magnesium oxychloride cement (12 mm)	pass
Dex-O-Tex P-61(M50)	A latex based terrazzo decking (12 mm)	pass
Fendolite MII(M56)	A vermiculite/portland cement mixture (25 mm)	pass
Duraspray(M55)	A magnesium oxychloride cement (18 mm) - 30 lbs/ft^3	pass
B. ORGANIC MATERIALS		
Asphalt Tile(M35)	A commercial asphalt deck tile (3 mm)	pass
Polyvinyl chloride Tile(M34)	A polyvinyl chloride deck tile (3 mm)	pass
Fiberboard(M46) fiberboard boat plank	An asphalt impregnated deck tile (12 mm)	pass

* Numbers in parentheses indicate the Laboratory Mark for the material tested

2.3 GENERAL MATERIALS

Thirteen other materials were investigated. The materials were selected without regard to their suitability for use as primary deck coverings. All materials were applied to 3 mm (0.12 in.) steel plate using a contact adhesive.

Test results are summarized in Table 3. These materials can be separated into two major categories: cellulostic wood products, and synthetic plastics and carpets. The cellulostic materials that passed included: chipboard, hardboard and corregated cardboard. The synthetic materials included: foamed polystyrene and polymethacrylate. Only cork and a synthetic carpet failed the test. The synthetic carpet

also failed the U.S. Department of Commerce Standard, FF 2-70. The effect of material thickness was investigated for three materials: balsa wood, basswood, and polystyrene. Using the pass/fail criteria of this test method, no effect of thickness was found.

Visual observations for the materials that failed suggested different failure mechanisms were important. The synthetic carpet fiber melted and formed flaming globules. Some of these globules fell from the sample surface, but most remained attached to the carpet backing. The afterflaming that was responsible for failure was a result of the retention of these flaming globules on the undersurface of the test sample. The cork expanded in the region of flame impingement and detached from the surface to form a 51 mm (2 in.) bubble. In this case, the afterburning was the result of a confined fire in the void between the test plate and the test material. A modification to the test procedure was made in which the test sample was placed in the normal position of use and the flame directed downward onto its surface. The cork did not ignite using this modification.

2.4 BULKHEAD FINISHES

Two special materials with known ASTM E-84 Flame Spread (FS) values were evaluated. Both special materials were polyvinyl chloride bulkhead finishes applied to 12 mm (1/2 in.) Marinite. Both bulkhead finishes, one having an ASTM E-84 Spread of Flame rating of 5 and the other of 130, passed the test. Test results for the bulkhead finishes are presented in Table 3B.

3.0 DISCUSSION

The test procedure prescribed in FP 31/WP.4, Annex 3, assumes that the fire threat consists of a cigarette or match dropped on the deck covering. All the primary deck coverings were found to be "not readily ignitable" using the pass/fail criteria specified. Similar tests (summarized in Appendix C) were reported by Japan [FP 33/INF.28]. Japan evaluated a broad range of deck coverings which contained organic materials. These included asphalt, and a variety of natural and synthetic polymers. Again, there were no failures. Since the materials evaluated in both projects were chosen to represent a cross section of those used on ships, it is doubtful that a more exhaustive survey of coverings would produce failures. Therefore, it is concluded that the test procedure does not provide a basis for discriminating between currently specified primary deck coverings with respect to the property "ease of ignitability."

These results suggest that none of the currently specified deck coverings are readily ignitable. This conclusion was expected because deck coverings must pass a more severe fire test prescribed in resolution A214(VII). Therefore, adoption of the

test outlined in FP 31/WP.4, and deletion of the requirement for A214(VII), would allow the use of more readily ignitable materials.

TABLE 3
PASS/FAIL RESPONSE OF SELECTED MATERIALS TO THE IMO FIRE TEST (FP 31/WP.4 Annex 3)

A. GENERAL MATERIALS

MATERIAL (Lab Mark)	THICKNESS (mm)	(in.)	FUEL LOADING (kg/m^2)	RESPONSE (pass/fail)
Chipboard(M58)*	7	9/32	4.2	pass
Hardboard(M59)	6	1/4	5.8	pass
Basswood(M61)	2.4	3/32	1.1	pass
Basswood(M67)	6	1/4	2.9	pass
Balsa wood(M62)	2.4	3/32	0.5	pass
Balsa wood(M63)	6	1/4	1.3	pass
Cardboard(M69)	4.5	3/16	0.6	pass
Cork(M64)	3	1/8	1.0	fail
Methacrylate(M66)	6	1/4	6.6	pass
Polystyrene(M57)	5	3/16	0.2	pass
Polystyrene(M68)	24	15/16	0.9	pass
Wool Carpet(M36)	100% wool fiber, jute back			pass
Synthetic Carpet(M60)	unknown fiber, synthetic back			fail

B. BULKHEAD FINISHES

Vinyl wallcover(M[illegible]9)	mounted on 6 mm (¼ in.) glass reinforced cement board	pass
Vinyl wallcover(M[illegible])	mounted on 12 mm (½ in.) Marinite marine board bulkhead	pass

* Numbers in parentheses indicate the Laboratory Mark for the material tested.

Materials such as balsa wood, polymethacrylate, and non-FR polystyrene rigid foams are generally considered to be readily ignitable. Although these materials would not be considered for use as primary deck coverings (because of their physical properties), they would be acceptable according to the pass/fail criteria of this test method.

One problem, in the design of the test procedure, is the use of an inverted test sample with the flame impinging from below. Primary deck coverings are mounted on the deck and can be exposed to direct flaming only from above. The use of an inverted sample changes the way heat is transferred to the sample and how the sample responds to this heating. For example, the delamination of the polyvinyl chloride tile would not occur if it were mounted normally. It is possible that the use of the inverted sample position could change the rank ordering of materials and either allow the use of unsafe materials or disallow the use of safe materials.

If the FP 31/WP.4 test is adopted, the test protocol needs clarification and/or modification on several technical points. These include:

- Tolerance limits should be specified on the OD and ID limits of the copper tube burner (suggest 5 $\pm$ 0.1 mm ID and 6 $\pm$ 0.1 mm OD). For adaptation to U.S. laboratories a standard wall 3/16 in. tubing should be specified.

- Tolerance limits should be specified for the composition and energy content of the natural gas used to fuel the burner.

- Consideration should be given to specifying the fuel flow rate for the burner.

- It is unrealistic in most laboratories to take a sample from a conditioning room and begin tests within two minutes (suggest that 15 minutes be allowed for this purpose).

- The conditioning requirements of 20 $\pm$ 2°C are unnecessarily tight (suggest that those specified by ASTM 662-84 be considered: i.e., 23 $\pm$ 3°C).

4.0 CONCLUSIONS/RECOMMENDATIONS

4.1 CONCLUSIONS

- All the primary deck coverings that were evaluated passed the proposed test. Therefore, the test does not provide a basis for discrimination with respect to the relative "ease of ignitability" for most existing primary deck coverings.

- Other materials which pass the test and are classified "not readily ignitable" include: chipboard, hardboard, foamed polystyrene, corregated cardboard, and balsa wood. Generally, these materials are considered to be readily ignitable. Therefore, the test does not ensure the exclusion of readily ignitable materials as primary deck coverings.

- The use of an inverted test sample results in changes in physical processes that do not occur for the same materials when mounted as they would be normally installed. These changes may affect the fire properties and rank ordering of some materials.

4.2 RECOMMENDATIONS

- The adoption of the proposed test method as a replacement to A214 VII is not recommended.

- If a test is required to prevent ignition by cigarettes and matches, consideration should be given to the use of U.S. Department of Commerce, Standard FF 2-70.

- If the test method is adopted, then the following additional investigations are recommended:

  A determination of whether the placement of the test sample in an inverted position can, in fact, change the rank order of materials with respect to ease of ignition.

  An evaluation of the validity of the test method as a predictor of fire safety for primary deck coverings by using large-scale fire tests.

APPENDIX A
IGNITABILITY TEST FOR PRIMARY DECK COVERINGS USED ON UNITED KINGDOM REGISTERED SHIPS (IMO FP31/WP.4, ANNEX 3)

1.0 TEST SPECIMENS

1.1 The specimens of primary deck covering materials are to be a minimum of 150 mm x 150 mm and of the thickness which is to be used on board ships and attached to 3 mm steel plating.

1.2 Three specimens of each type of deck covering are to be prepared.

2.0 ATMOSPHERE FOR CONDITIONING OF TEST SPECIMENS

2.1 The conditioning atmosphere shall have a temperature of 20 $\pm$ 2°C and relative humidity of 55 $\pm$ 10%.

2.2 The specimens shall be laid flat, singly and with the steel plating on the underside in the conditioning atmosphere for a period of 24 hours, or for a longer period which is sufficient to ensure that the mass of each specimen shows no progressive change greater than 0.25% when it is determined at intervals of two hours.

3.0 ATMOSPHERE FOR TESTING

3.1 The test is to be conducted in an atmosphere the same as for conditioning the specimens, or within two minutes of removal from the conditioning atmosphere.

3.2 Measures shall be taken to prevent drafts in the vicinity of the testing equipment when testing is in progress.

4.0 TESTING PROCEDURE

4.1 Source of ignition. The source shall be obtained by using a burner consisting of a copper tube having a length of 150 mm and inside and outside diameters of 5 mm and 6 mm, respectively, connected with plastic or rubber tubing to a gas tap supplying natural gas. The copper tube is to have no opening for the supply of air.

4.2 Height of Flame. Before the test takes place the burner flame is to be adjusted to a height of 32 mm.

4.3 Test procedure.

4.3.1 Place a specimen horizontally on a metal tripod stand with the upper surface of the specimen facing downwards (i.e., with steel plating uppermost). The height of the tripod stand is to be adjusted so that the top of the burner flame is approximately 8 mm above the underside of the specimen on the tripod. Apply the burner flame at right angles to the plane of

the specimen in the center of the specimen. After one minute the burner is to be removed clear of the specimen and the time in seconds to extinction of any flaming is to be recorded.

4.3.2 The test in 4.3.1 is to be repeated after the specimen has been allowed to cool down except that the center of the burner flame is to be positioned at the midpoint of any edge of the specimen and again the time in seconds to extinction of any flaming after the removal of the burner is to be recorded.

4.3.3 The tests in 4.3.1 and 4.3.2 are to be carried out on the two remaining specimens.

5.0 PASS CRITERIA

5.1 A deck covering is deemed to be not readily ignitable if:

5.1.1 none of the three specimens flames after the removal of the burner; or,

5.1.2 the flaming of any specimen ceases within 20 seconds of the removal of the burner.

APPENDIX B
LIST OF MATERIALS

M9*. A vinyl chloride wallcovering. B.F. Goodrich, Type I-G. Thickness--0.53 mm (0.21 in.). Unit weight--10.3 oz/yd^2 (0.353 kg/m^2)**. Material backing--cheesecloth. Applied using B.F. Goodrich A-848-D adhesive to 12mm (1/2 in.) Marinite marine board. Material when mounted on GRC and Marinite had ASTM E 84-84 Flame Spread Index ratings of 5 and 20, respectively. Manufacturer--B.F. Goodrich Company, Akron Ohio.

M18. A non-woven vinyl wallcovering. The material was a non-commercial developmental fabric having an ASTM E 84-84 Flame Spread Index of 130 when mounted on Marinite. Thickness--0.635 mm (0.025 in.). Applied to 12 mm (1/2 in.) Marinite marine board using Borden Cascovin E 8825 adhesive.

M34. A polyvinyl chloride deck tile (TE 68). Thickness--3 mm (1/8 in.). Applied to 3 mm (1/8 in.) steel plate using a contact adhesive. Weight loading*** 2.98 kg/m^2 (0.60 lbs/ft^2. Supplier--Carpetek, 62 Boston Post Road, Waterford, CT, 06385.

M35. An asphalt deck tile. Corktone #802, D-247 Kentile. Thickness--3 mm (1/8 in.). Applied to 3 mm (1/8 in.) steel plate using a latex contact adhesive. Supplier--Carpetek, 62 Boston Post Road, Waterford CT, 06385.

M36. Carpet--100% wool--cut pile facing.--Supplier: Carpet Giant, New London Shopping Center. Supplier reported the carpet was the same as that used on the CGC VIGOROUS.

M46. Asphaltic boat planking with topping. Johns Manville "Bridgeplank". Total thickness--11 mm (7/16 in.). Topping thickness--1.6 mm (1/16 in.). Applied to 3 mm (1/8 in.) steel using Johns Manville Bridge Cement 7000W1 #1 at application rate of 50 ft^2/gal (0.84 l/m^2). Supplier--C.G. Edwards, 272 Dorchester Ave., Box 358, Boston, MA, 02127.

M50. A resin/terrazzo primary deck covering. Dex-O-Tex Terrazzo M. Thickness--12 mm (1/2 in.). Applied to 3 mm (1/8 in.) steel plate by commercial applicator. Manufacturer--Crossfield Products Corp., Eastern Sales, 140 Valley Road, Roselle Park, New Jersey, 07204.

M52. A commercial magnesite (magnesium oxychloride cement), Duracrete. Thickness--12 mm (1/2 in.). Density--90 lbs/ft^3 (1440 kg/m^3). Applied to 3 mm (1/8 in.) steel plate. Manufacturer--Stan Chem, Inc., 401 Berlin Street, East Berlin, CT, 06023.

* Laboratory Mark for material tested.
** Values in parentheses are converted from the preceeding experimental values.
*** Weight loading of "combustible" material per unit area.

M55. A glass fiber-reinforced foamed magnesite for interior use. Duraspray. Thickness--18 mm (3/4 in.). Density--30 lbs/ft^3 (480 kg/m^3). Applied to 3 mm (1/8 in.) steel plate using Albi 487S primer. Manufacturer--Stan Chem, Inc., 401 Berlin Street, East Berlin, CT, 06023.

M56. A vermiculite/portland cement mixture. Fendolite MII. Thickness--25 mm (1 in.). Weight loading: 23.7 kg/m^2 (4.74 lbs/ft^2). Applied to 3 mm (1/8 in.) steel plate over Albi 487S primer. Manufacturer--Mandoval Limited, Mark House, The Square, Lightwater, Surrey, Great Britain, GU185SS, Telephone Bagshot (0276) 71617.

M57. Polystyrene, foamed, 5 mm (3/16 in.). Meat tray from Waldheim Food Mart. Substrate 3 mm (1/8 in.) steel. Latex based pressure contact adhesive bonding agent. Application rate of adhesive unknown. Weight loading: 0.2 kg/m^2 (0.04 lbs/ft^2).

M58. A commercial chipboard. Thickness--7 mm (9/32 in.). Exterior glue. Applied to 3 mm (1/8 in.) steel using a latex based contact adhesive. Application rate of adhesive unknown. Weight loading: 4.2 kg/m^2 (0.84 lbs/ft^2). Distributor: Grossmans Supply, Newington, CT.

M59. A commercial hardboard. Thickness--6 mm (1/4 in.). Exterior glues. Applied to 3 mm (1/8 in.) steel using a latex based contact adhesive. Weight loading: 5.8 kg/m^2 (1.16 lbs/ft^2). Supplier: Grossmans Supply, Newington, CT.

M60. A broadloom cut pile carpet of undetermined fiber content. Pile height 6 mm (1/4 in.). Backing synthetic polyolefin. Applied to 3 mm (1/8 in.) steel plate using a latex based contact adhesive. Application rate of adhesive unknown. Distributor: Nance Carpet & Rug Company. Material labeled as: "Flammable (fails U.S. Department of Commerce Standard FF2-70); should not be used near sources of ignition". Purchased from Zayre, Newington CT.

M61. Basswood applied to 3 mm (1/8 in.) steel plate using Chapco 345 adhesive. Thickness--2.4 mm (3/32 in.). Material applied in 3-inch widths (2 each) with joint at center of steel plate. Weight loading: 1.1 kg/m^2 (0.22 lbs/ft^2). Retail outlet--"Toys", Groton, CT. Adhesive distributor for Chapco 345 -- Carpetek, 62 Boston Post Road, Waterford, CT, 06385.

M62. Balsa wood applied to 3 mm (1/8 in.) steel plate using Chapco 345 adhesive. Thickness--2.4 mm (3/32 in.). Material applied in 3-inch widths (2 each) with joint at center of steel plate. Weight loading: 0.5 kg/m^2 (0.10 lbs/ft^2). Retail outlet--"Toys", Groton, CT. Adhesive distributor for Chapco 345 -- Carpetek, 62 Boston Post Road, Waterford, CT, 06385.

M63. Balsa wood applied to 3 mm (1/8 in.) steel plate using Chapco 345 adhesive. Thickness--6 mm (1/4 in.). Material applied in 3-inch widths (2 each) with joint at center of steel plate. Weight loading: 1.3 kg/m^2 (0.26 lbs/ft^2). Retail outlet "Toys", Groton, CT. Adhesive distributor for Chapco 345 -- Carpetek, 62 Boston Post Road, Waterford, CT, 06385.

M64. Cork #1 applied to 3 mm (1/8 in.) steel plate using Chapco 345 adhesive. Thickness--3 mm (1/8 in.). Weight loading: 1.0 kg/m^2 (0.20 lbs/ft^2).

M66. Plexiglass applied to 3 mm (1/8 in.) steel plate using Chapco 345 adhesive. Thickness--6 mm (1/4 in.). Weight loading: 6.6 kg/m^2 (1.32 lbs/ft^2).

M67. Basswood applied to 3 mm (1/8 in.) steel plate using Chapco 345 adhesive. Thickness--6 mm (1/4 in.). Weight loading: 2.9 kg/m^2 (0.58 lbs/ft^2). Supplier--"Toys", Groton, CT.

M68. Polystyrene applied to 3 mm (1/8 in.) steel plate using Chapco 345 adhesive. Thickness--24 mm (15/16 in.). Weight loading: 0.9 kg/m^2 (0.18 lbs/ft^2). Supplier -- Grossmans Hardware, Groton, CT.

M69. Corregated cardboard applied to 3 mm (1/8 in.) steel plate using Chapco 345 adhesive. Thickness--5 mm (3/16 in.). Weight loading: 0.6 kg/m^2 (0.12 lbs/ft^2). Supplier -- Grossmans Hardware, Groton, CT.

APPENDIX C
SUMMARY OF TEST RESULTS REPORTED IN FP 33/INF.28

Material Type	Thickness (mm)	Pass/Fail
Asphalt	9	Pass
Chloroprene Latex	8	Pass
Neoprene Latex, Natural Latex	9	Pass
Styrene/Butadiene Latex	8	Pass
Acrylic Emulsion	9	Pass
Acrylic/Styrene Emulsion	8	Pass
Natural Latex Rubber	10	Pass
Epoxy Resin	4.5	Pass
Natural Latex, Artificial Rubber	10	Pass
Chloroprene Latex	7.5	Pass
Chloroprene Latex	7.5	Pass
Styrene/Butadiene Latex	35	Pass
Styrene/Butadiene Latex	7	Pass
Asphalt	3	Pass